A COMPENDIUM OF FORTIFICATION,

BOTH

Geometrically and Instrumentally,

BY A

SCALE,

The Making whereof is shewed by the Tables, and their Use, both of the Tables and the Scale, for speedy Protracting of any Fort consisting of 8 Bulwarks, whose Bastion-Angles shall not exceed 90 Degrees; and so the like for Bastion-Angles of 12 Bulwarks.

WRITTEN BY

PHILIP STAYNRED

Professor and Teacher of the MATHEMATICKS in the City of BRISTOL.

JER. XVI. 19.

The Lord is my strength, and my fortress, and my refuge in the day of affliction.

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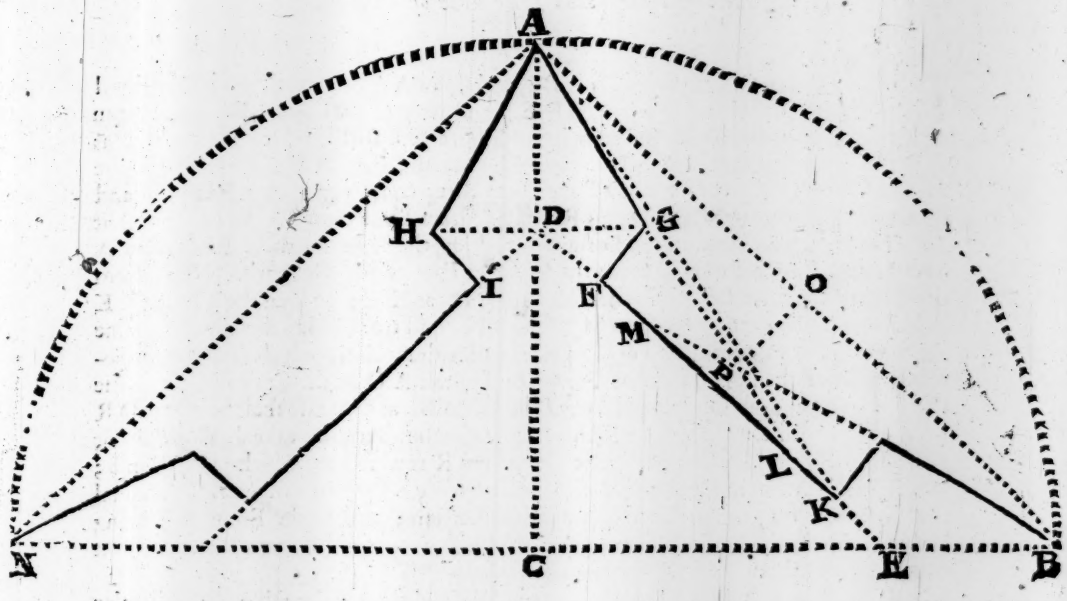
1288:84

A COMPENDIUM OF FORTIFICATION.

FIrſt, I will deſcribe part of a Tetragon or Square Fort, and explain the Names of the Sides and Angles thereof, as in the Figure following.



Names of the Sides of a Fort.

A B the Outward Side of the Polygon, and D E the Inward Side.
C A the Semidiameter of the Outward Polygon, and C D the Inward.
I H A G F the Bulwark or Baſtion.
A G, or A H, the Front or Face of the Baſtion ——— 280 *Foot.*
A D the Capital or Head Line,
D I, or D F, the Gorge Line.
I H, or F G, the Flank; and F M the ſecond Flank.
D G the Eſpaule, or Shoulder.
F K the Curtain ——— 420 *Foot.*
A K the longeſt Line of Defence ——— 720 *Foot.*
A L the ſhorteſt Line of Defence.

Names of the Angles.

N A B the Angle of the Polygon, and N A C the half Angle.
H A G the Flanked Angle of the Bulwark.

 A G F

A G F the Angle of the Shoulder.
F D G the Angle forming the Flank, commonly 40 Degrees.
G A O the Inward Flanking Angle.
A P B the Outward Flanking Angle, and A P O half the ſame.

Note, That the Baſtion or Flanked Angle H A G muſt never be leſs than 60 Degrees, neither above 90 Degrees; but as neer as you can to an Angle of 90 Degrees: So that it may be defended from the Flank and Curtain on either ſide.

The longeſt Line of Defence K A not to be above 12 ſcore Yards, that is, 720 Foot, being within Musket-ſhot; and the breadth of the Rampire to reſiſt the Battery 100 Foot.

To Deſcribe a Fort of Five Bulwarks, or any other; ſo that the Baſtion, or Flanked Angle of 8 Baſtions or Bulwarks exceed not 90 Degrees by the Line of Chords.

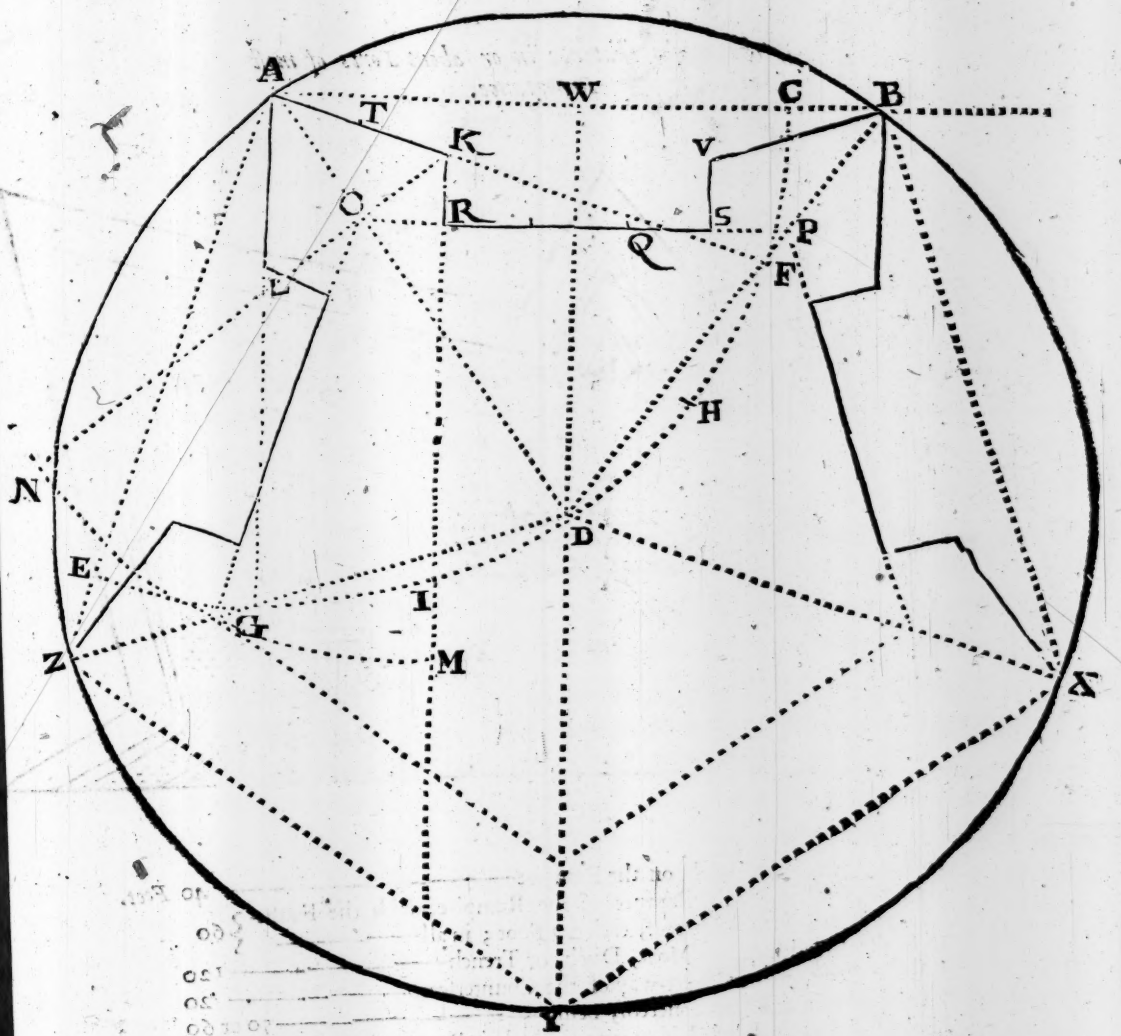
FIrſt, Draw an Obſcure Line, as A B; and upon A, as a Center, with the Chord of 60 *deg.* deſcribe an Arch, as C D E; and from C lay down half the Polygon Angle (which in the Table following the Figure you ſhall find to be) 54 *deg.* as C D; alſo the ſame again from D to E, and draw the Line A E. Now divide the half Polygon Arches C D and D E each into three equal parts, as in F H I G, and from two of thoſe parts from D, as F and G, draw Lines unto the Baſtion Point at A. Then take any convenient Diſtance, and lay the ſame on thoſe Lines from A unto K and L, which ſhall make the Front or Face of the Bulwark. Next, from the ſhoulder at K let fall a Perpendicular to A B, as K M; and on the Center at K deſcribe an Arch of 60 *deg.* from M towards N, and from M lay down on the ſame Arch 50 *deg.* or more exact 49 *deg.* 24 *min.* and ſo draw K N, which will cut the Semidiameter of the Polygon in the Point O; ſo ſhall A O be the Capital Line of the Baſtion. Then from O draw a Line parallel to A B, as O P; ſo ſhall you have O R for the Gorge Line, and R K the Flank. Now for the Curtain, take half the Front A K, as A T, and lay it down three times from R towards P, which will fall in S; ſo is R S the Curtain. Then on the Point at S erect a Perpendicular, as S V, equal to R K, which ſhall be the Flank of another Baſtion; and ſo the Front K A being laid from V, ſhall cut the firſt Line A B in B; ſo drawing V B, you have the Front of the ſame Baſtion.

Laſtly, Divide A B in the middle, as in W, and from W let fall a Perpendicular to A B, which will cut the Semidiameter of the Polygon in the Point D; ſo is D the Center of the Polygon. And with the ſame Semidiameter D A you muſt deſcribe a whole Circle, of the which A B is the $\frac{1}{5}$ part thereof, which Diſtance will reach from B unto X, and from X unto Y, and ſo to Z, and your firſt Point at A, where you begun your Work.

For the other Baſtions, they may be eaſily tranſported from the firſt Baſtion. And note, That if your Fort exceed 8 Bulwarks, you muſt add 15 *deg.* to halt the Polygon Angle, ſo have you the Baſtion Angle; and then work as before. But in the Forts that exceed not 8 Bulwarks, where the Baſtion Angle will not be above 90 *deg.* you muſt take the $\frac{2}{3}$ part of the Angle of the Polygon.

The longeſt Line of Defence is from A unto Q, and ſhould not exceed 720 Foot (becauſe of being within Musket-ſhot) the Curtain R S about 420 Foot, and the Front A K 280 Foot: And for the Flank R K, and Gorge R O, their proportion commonly is as 6 to 7: but the Angle K O R forming the Flank is about 40 *gr.* by which the Proportion is neer as 5 to 6.

A Table



A Table for 8 Bastions.

	Polygons.	*½ Angle of the Polygons*	*½ Angle of the Bastions*
		Degrees.	*Degrees.*
4	Tetragon	45	30
5	Pentagon	54	36
6	Hexagon	60	40
7	Heptagon	64 2/7	42 6/7
8	Octagon	67 1/2	45

The ½ Bastion Angle is here found by taking the ⅔ of the ½ Polygon Angle: So the Bastion Angle will be an Angle of 90 *degr.* in the *Octagon.* And no more must the Bastion Angle be in any Polygon.

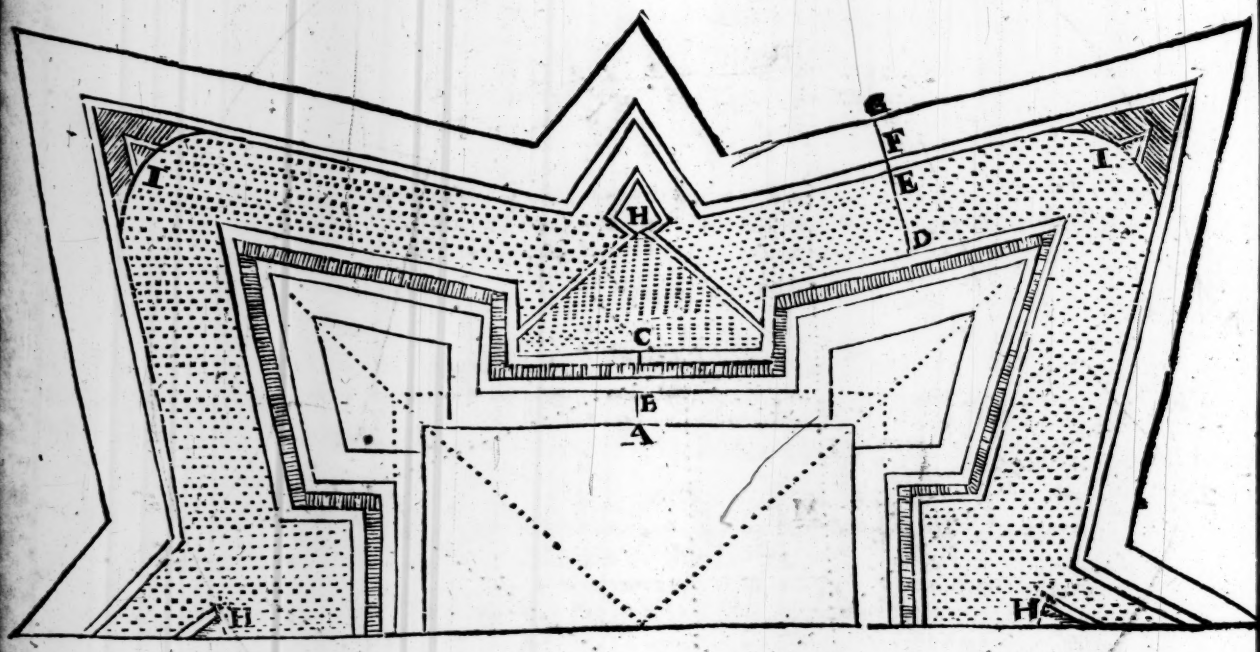
A Table for 12 Bastions.

	Polygons.	*½ Angle of the Polygon.*	*½ Angle of the Bastion.*
		Degrees.	*Degrees.*
4	Tetragon	45	30
5	Pentagon	54	34 1/2
6	Hexagon	60	37 1/2
7	Heptagon	64 2/7	39 2/14
8	Octagon	67 1/2	41 1/4
9	Enneagon	70	42 1/2
10	Decagon	72	43 1/2
11	Undecagon	73 7/11	44 7/22
12	Dodecagon	75	45

The ½ Bastion Angle is here found by adding 15 *d.* to ½ the Polygon Angle, and take the ½ thereof: So the Bastion Angle will be an Angle of 90 *deg.* in a *Dodecagon.*

Of

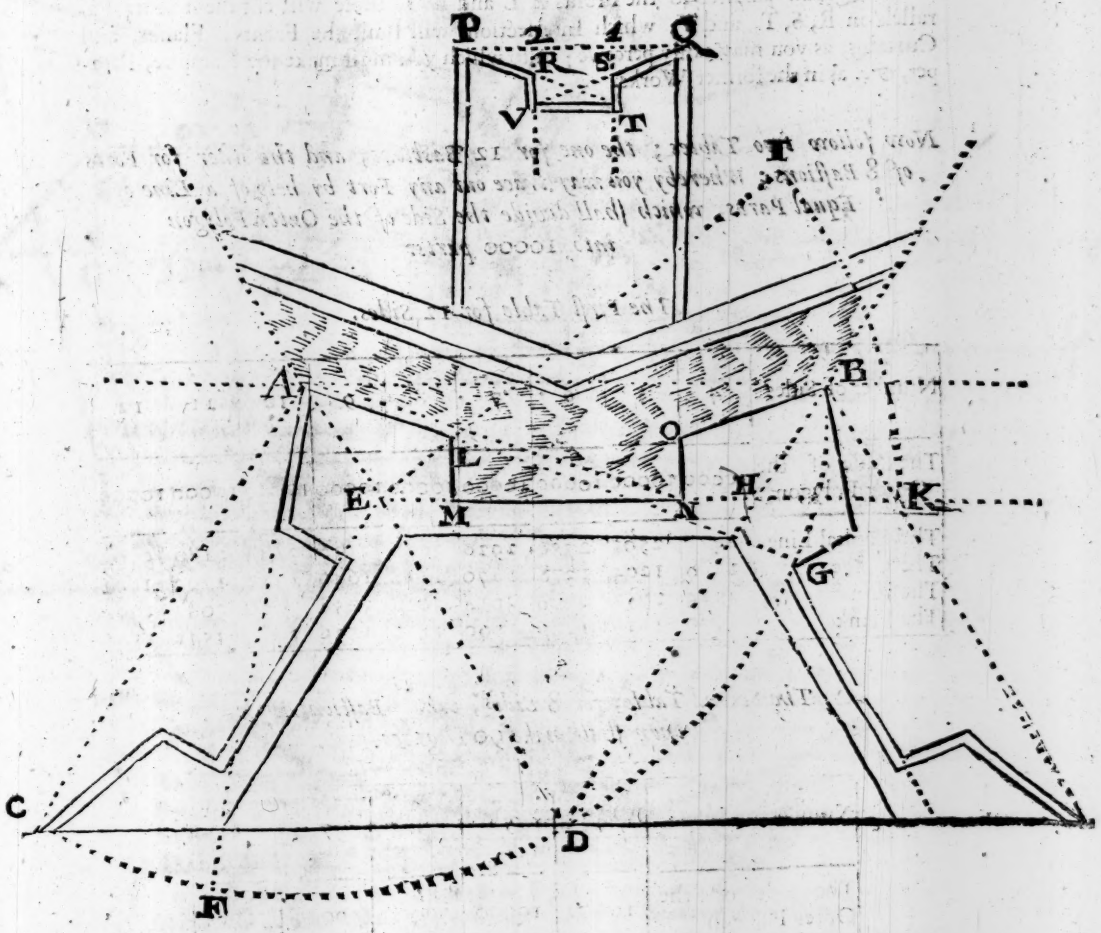
Of the Works that are in or about Forts of moſt Importance.



A B the Breadth or Walk on the Rampire	40	*Feet.*
B C the Breadth of the Parapet of the Rampire, with the Fauſſe-bray, and Parapet thereof, each 20 Foot; in all	60	
D E the Breadth of the Moat, Ditch, or Trench	120	
E F the Coridon, or Covert-way of the Counterſcarp	20	
F G the Argin or Parapet thereof, being	50 or 60	
H the Ravelines; I the Half-moons, with their Parapets	20	

There may be ſometimes an occaſion in Forts to raiſe Mounts, Cavaliers, Platforms, or Batteries, to command all the other Works, and to view the Country about; which may be raiſed upon the Baſtions, if you have room withal to make uſe of the Flanks: Otherwiſe let them be raiſed on the Curtains, a little within the Rampire, ſo that you may have room left for the Walk.

To Draw the Platform of a Fort, beginning with the Capital (or Head) Line; And alſo to draw the Horn-works.



LEt the Fort be an *Hexagon*, that is, of ſix Baſtions or Bulwarks. Firſt draw the Line A B, and upon A deſcribe an Arch of a Circle, as B D C, whereon lay down half the Polygon-Angle, which in the former Table you ſhall find to be 60 *deg.* as from B unto D, and thence to C; and draw A C and A D. Now the $\frac{1}{3}$ part of the half Polygon Angle is B G and C F; then draw the Obſcure Line A F and A G. Next you ſhall make choice of the Capital Line, of any ſufficient length, which let be A E; and from E draw a Line parallel to A B, as E H, continued; and upon the Point E, as a Center, deſcribe K I, making it an Angle of 40 *deg.* as K E I; ſo ſhall E I cut out the Front in L, as A L: So from L let fall the Perpendicular L M, which ſhall be the Flank; and M N the Curtain ſhall be as formerly the whole length of the Front, and a half more. For the reſt of the Work, you muſt proceed as formerly.

For

For the Horn-works.

YOu muſt continue the Flankers M L and N O unto P and Q; then take the longeſt Line of Defence A N, and lay it thereon from the ſhoulders at L and O, unto P and Q; drawing the Line P Q, dividing it into three equal parts; and from thoſe parts 1 and 2, draw parallels unto P L and Q O: alſo from thoſe Points P and Q draw parallels to the Fronts A L and B O, thoſe will cut the former Parallels in R, S, T, and V, which Interſections will limit the Fronts, Flanks, and Curtains, as you may eaſily perceive; unto which you muſt make the Rampire, Parapet, *&c.* as in the former Works.

Now follow two Tables; the one for 12 *Baſtions, and the other for Forts of* 8 *Baſtions: whereby you may trace out any Fort by help of a Line of Equal Parts, which ſhall divide the Side of the Outer Polygon into* 10000 *parts.*

The Firſt Table for 12 *Sides.*

Number of Sides	4	5	6	7	8	9	10	11	12
The Side of the Outer Polygon	10000	10000	10000	10000	10000	10000	10000	10000	10000
The Capital Line	2428	2592	2756	2926	3086	3136	3148	3180	3204
The Gorge	1088	1264	1378	1470	1538	1640	1722	1792	1842
The Front	2914	2952	2986	3014	3024	3054	3070	3082	3094
The Flank	970	1128	1246	1360	1516	1526	1536	1542	1546

The Second Table, for 8 *Sides, whoſe Baſtion Angle then ſhall make* 90 *Degrees.*

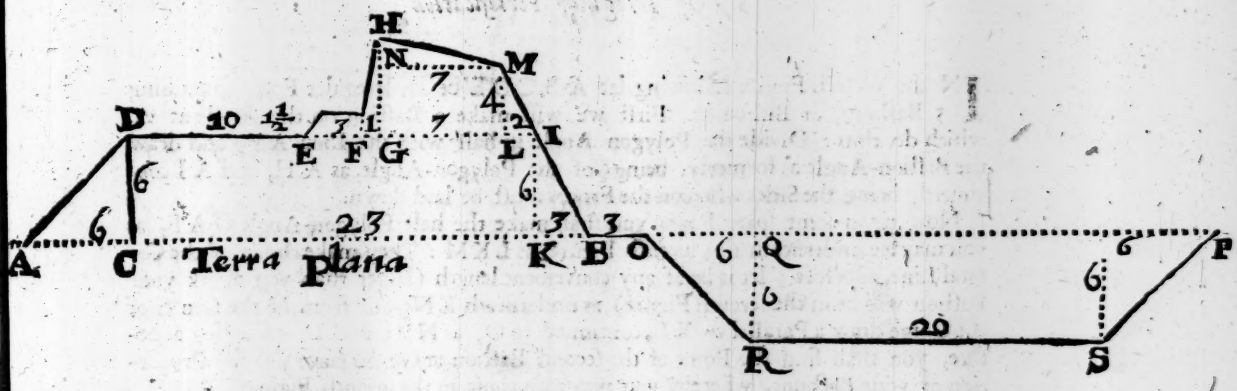
Number of Sides	4	5	6	7	8
The Side of the Outer Polygon	10000	10000	10000	10000	10000
The Capital Line	2396	2498	2602	2695	2778
The Gorge	1120	1327	1480	1599	1698
The Front	2914	2939	2959	2975	2987
The Flank	940	1113	1242	1342	1423

The Uſe of theſe Tables.

LEt it be required to draw the Proportional Dimenſion of a Regular Fort of 6 Sides: As for Example, in the fourth Figure, whoſe Side A B muſt be divided into 100 equal parts, and each part ſuppoſed to be ſubdivided into 10 parts; ſo have you 1000 parts, which ſhall ſuffice. Now proceeding according to former Directions, until you come to make choice of your Capital Line, you ſhall here find in the ſecond Table, which is beſt for the purpoſe, under the Figure 6, and right againſt the word *Capital* in the firſt Column, 2602, but 260 will ſerve: Take the

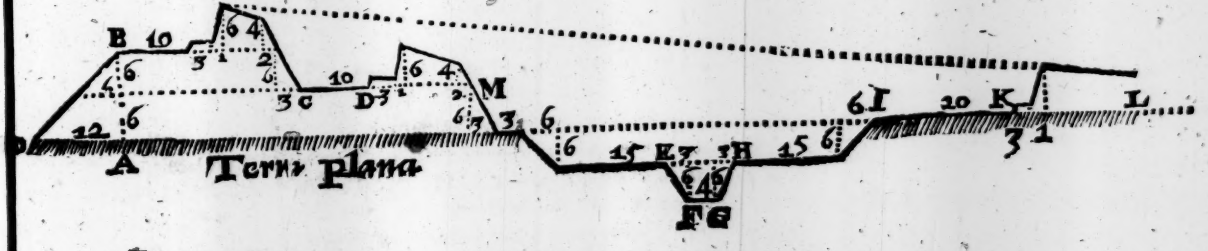
ſame

ſame from the Scale of Equal parts, and lay it from the Baſtion Point at A, and it falls in the Point E, which will be the Center of the Baſtion. From thence you may lay down the Gorge Line out of the Table, which is 148 unto M: So will the Front A L be 296, and the Flank M L. The Curtain, being once and a half the length of the Front, will be M N 444. Thus you may do for any of the reſt. Theſe Tables are uſeful for Irregular Forts; But firſt I will ſhew you the Height, Breadth, and Scarpings of the Rampire, Parapet, Ditch, *&c.* of theſe Sconces, as they are repreſented in the Profile, or Section, as followeth.



The Breadth of the Rampire may be 24, 30, or 40 Foot; but here A B is but	32
The Inward Scarp A C	6
The Height of the Rampire C D	6
The Breadth of the Walk of the Rampire D E	10
The Breadth of the Bank or Foot-pace of the Parapet E F	3
and the Height of the ſame Foot-pace	1½
The Inward Scarp of the Parapet F G	1
The Inward Height of the Parapet G H	6
The Breadth of the Parapet at the Foot F I	10
The outward Scarp of the Rampire B K	3
The Inward Scarp of the Parapet I L	2
The Outward Height of the Parapet L M	4
The Thickneſs of the Parapet at the top M N	7
The Brim of the Ditch B O	3
The Breadth of the Ditch at the top O P	32
The Scarp of the Ditch O Q	6
The Depth of the Ditch Q R	6
The Breadth of the Ditch at the Bottom R S	20

The Profile or Section of a Fort with a Fauſſe-Bray and Counterſcarp; alſo Subtrenched.



C D is the Fauſſe-bray, and D M his Parapet: E F G H is the Subtrench, and I K the Coridor, or Covert-way. Laſtly, K L is the Argin or Parapet of the

Counterſcarp. Note, That the Height of the Rampire A B ought to be raiſed 15 or 18 Foot above the *Terra Plana*, although here it is but 12 Foot, which is ſomewhat too low to command the Trench or Ditch: But if the Trench be made broader, then it will command the bottom thereof.

Of Irregular Fortification.

IN the ſeventh Figure following let A B C D E be an Irregular Fort, containing 5 Baſtions, or Bulwarks. Firſt we will make a Baſtion on the Angle at A, which do thus: Divide the Polygon Angle in half with the Line A F, and draw the Baſtion-Angle as formerly, being $\frac{2}{3}$ of the Polygon-Angle, as A H, and A I continued, being the Sides whereon the Fronts muſt be laid down.

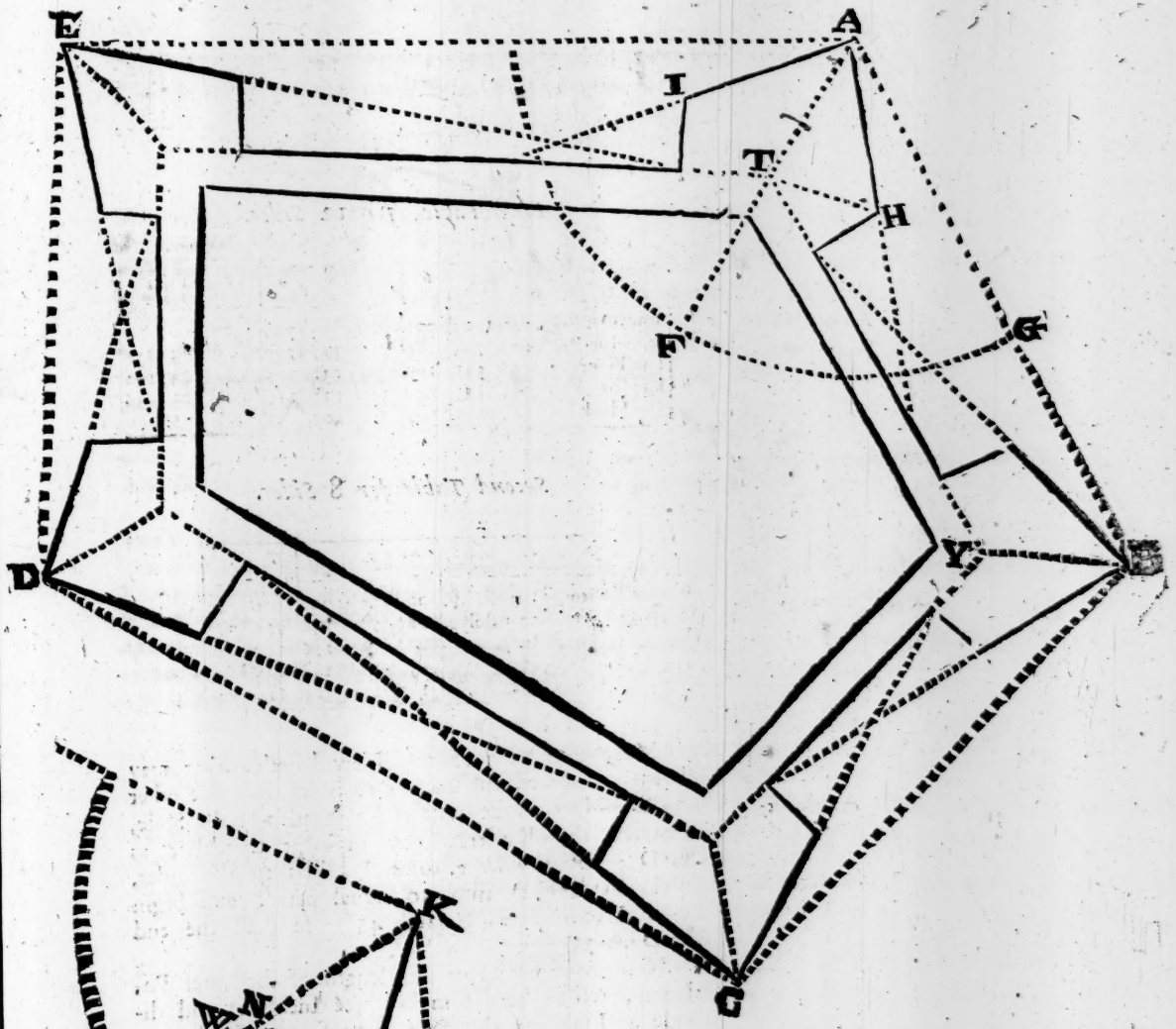
Now upon ſome ſpare Paper you ſhall make the half Polygon-Angle G A F, as you may ſee underneath this ſeventh Figure, as L K M: Then make choice of the Capital Line, as before; let it be of any convenient length (larger than you think your Baſtion will be in the ſeventh Figure) as underneath K N, and from N the Center of the Gorge draw a Parallel to K L, continued to O, as N P; and ſo proceeding as before, you ſhall find the Point of the ſecond Baſtion at O: So have you the Proportion of your Baſtions, whereby you may gain thoſe in the ſeventh Figure.

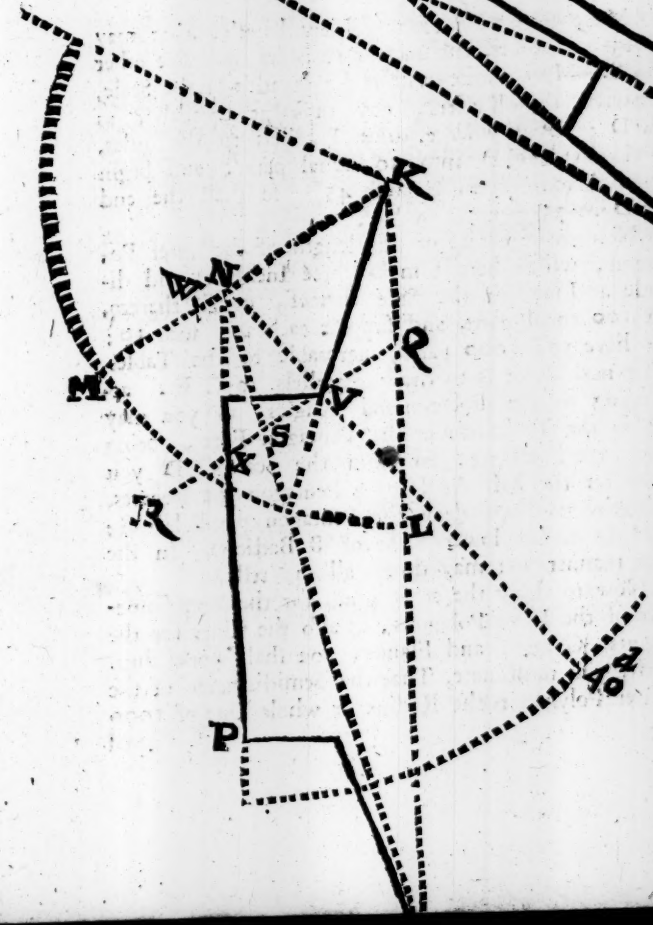
Now to reduce it from the Baſtion Point at A, you muſt take A B the ſhorteſt ſide, and lay it from O unto Q; and from Q draw a Line parallel to the Capital Line K N continued, as Q R. Laſtly, drawing a Line from N to O, it ſhall cut Q R in the Point S; ſo is Q S the length of the Capital Line ſought for, which muſt be laid down on the ſeventh Figure from A unto T; ſo is T the Center of the Gorge. Then for the Front take K V, and lay it on the Capital Line from K to W: ſo a Ruler being laid from W to O, it ſhall cut the Line Q R in the Point at X; ſo is Q X the length of the Front, to be laid down in the ſeventh Figure from A unto H and I. Thus ſhall you finiſh your Baſtion, when you have let fallen your Flanks perpendicular on the ends of your Curtains, as you ſee. The like Method you are to obſerve for the other Baſtions.

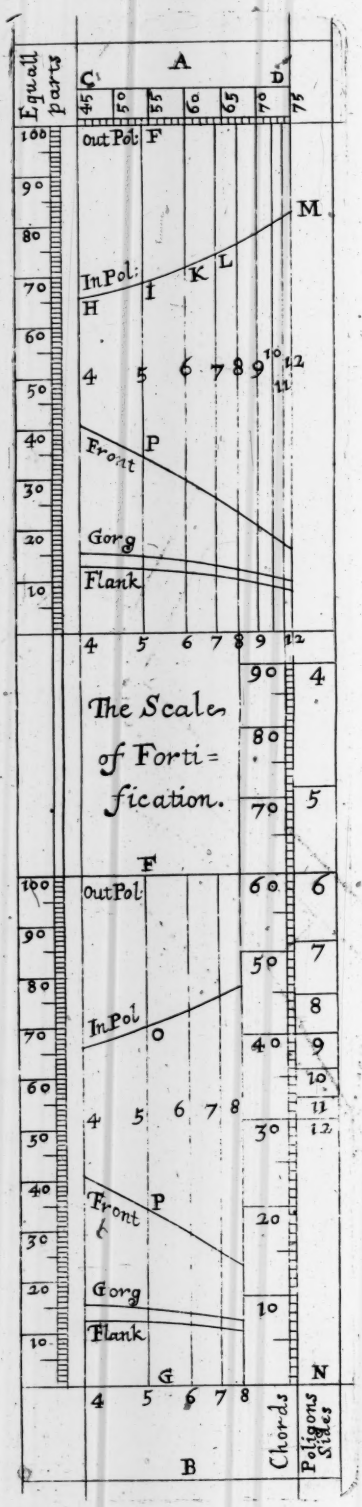
And when you have finiſhed your Fort, you muſt obſerve whether your Curtain Lines (that is, from the Centers of the Gorge) be parallel to the outward Sides A B, *&c.* which if they are not, you muſt correct them; and by your Judgment, by help of the Lines of Defence, you may as you ſee occaſion widen the Necks of the Gorges, and alſo the Baſtion Angles; but not above 90 Degrees: And ſo let the Flankers be as neer proportional as the Rules (or Ocular Demonſtration directeth) which commonly the Gorge Line to the Flank bears proportion as 7 to 6.

Much more could I write of Irregular Fortification: but my purpoſe at this time is but to make a ſmall Treatiſe, or an Epitome thereof.

The ſeventh Figure, of an Irregular Fort, containing 5 *Baſtions; being the Platform of the Royal Fort ſometimes on St.* Michael's Hill, *on the North weſt Side of the City of* Briſtol.







To make a Scale for Fortification by the Tables.

THis may be performed Geometrically by obſerving the former Inſtructions, whereby you may gain the length of every Line: but it will be ſooner done, and more eaſie, by theſe Tables following.

Firſt Table, for 12 Sides.

Numb. of Sides	4	5	6	7	8	9	10	11	12
Semi. Out. Pol.	1000	1000	1000	1000	1000	1000	1000	1000	1000
Semi. Inn. Pol.	661	700	731	756	777	795	810	823	834
The Front	412	347	299	261	232	209	190	174	160
The Gorge	158	151	141	132	123	115	108	101	96
The Flank	133	127	119	111	103	97	90	85	80

Second Table for 8 Sides.

Nnmber of Sides	4	5	6	7	8
Semi. Outer Polyg.	1000	1000	1000	1000	1000
Semi. Inner Polyg.	661	706	740	766	787
The Front	412	346	296	259	229
The Gorge	158	156	148	138	130
The Flank	133	131	124	116	109

Make your Scale of a ſufficient length, that may hold both Lines, the one for 12 Sides, and the other for 8. Make choice within the breadth of the Scale, between the Borders, any ſufficient breadth, as C D; from whence draw Parallels to the Sides, and divide C D into 90 Equal parts, and begin your Account from C with 45: ſo ſhall the end at D be 75 *degr.*

Now make choice of the length of the outer Polygon, which here I make three Inches; and divide a Line by the Side thereof, equal thereto, in 100 equal parts, and ſuppoſe each part into 10; ſo have you 1000 parts, agreeable to the Tables. The next thing is to draw Parallels to C E, according to the Polygon half Angles, as you may ſee in the Tables under the Pentagon Fort, being the ſecond Figure: So from the Scale C D you have for the half Angle of a Pentagon 54 Degrees, whereby you may draw the Pentagon parallel F G; and ſo in the lower Scale of 8 Baſtions. In the like manner you may do for all the reſt.

Now to draw the croſs Lines for the Semidiameters of the Inner Polygons, as alſo the Lines for the Fronts, Gorges, and Flanks, you ſhall work thus. Firſt, you muſt note, That the Semidiameter of the Outer Polygon is the Radius or whole Line of 1000 equal

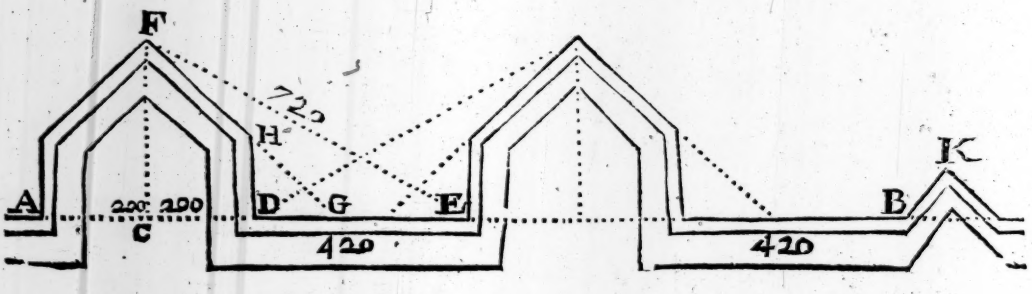
equal parts, and that is drawn at Right Angles, or a croſs at F: But for the Semidiameter of the Inner Polygon, look in the Table of 12 Sides in the ſecond Column under 4, you have 661. Take the ſame Number off your Scale of Equal Parts, and lay it from E to H: Then in the third Column under 5 you have 700 parts; lay the ſame down from G to I, and make there a prick or point: Do the like for the *Hexagon* and *Heptagon*, as at I and K; proceeding along with all the reſt, unto the *Dodecagon*. And laſtly, draw a Line through all thoſe Points: So have you the Arch Line H M for the Semidiameters of the Inner Polygon. In the ſame manner work for the Front, Gorge, and Flank Lines. The Scale of 8 Sides is the ſame Method.

I have alſo inſerted on the left ſide of the Scale a Line of Chords, whoſe Radius (or Arch of 60 Degrees) is three Inches; and on the left ſide, a Line for the Sides of the Polygons. The *Hexagon*, or ſix Sides, is equal to the Radius: And for the *Tetragon*, or four Sides, it is equal to the Chord of 90 Degrees. So having deſcribed a whole Circle with the Chord of 60 Degrees, you ſhall find, that if you take from the Center N unto 5, it ſhall divide the Circle into 5 equal parts, for drawing the Figure of a *Pentagon*, which in the ſecond Figure of a *Pentagon* Fort will reach from A to B, and ſo to X, Y, Z, and A. Now D A in the ſame ſecond Figure you ſhall find to be the Semidiameter of the Outer Polygon, which in the Scale is G F; and taking G I off the Scale for 12 Baſtions, or G O on the Scale of 8 Baſtions, it will give the Semidiameter of the Inner Polygon, as D E in the ſame Figure. So likewiſe G P on the Scale will be equal to the Front A K in the *Pentagon* Fort. The like you may underſtand for laying down the Gorge and the Flank. And for the Curtain, as before, you muſt make R S 1 $\frac{1}{5}$ the length of the Front A K.

This Scale will alſo be of good Uſe in Irregular Fortification. As for Inſtance. In the Irregular Fort, the ſeventh Figure, you ſhall find the half Baſtion Angle G A F to be 58 Degrees, which falls on the Scale between the *Pentagon* and *Hexagon*, from whence you may draw a Baſtion on ſome ſpare place, and from thence proportionate the ſame unto the outer ſide of the ſeventh Figure A B. The reſt I leave to your own practice.

How

How to Fortifie a long Curtain with Bulwarks, or a ſtrait Town Wall.

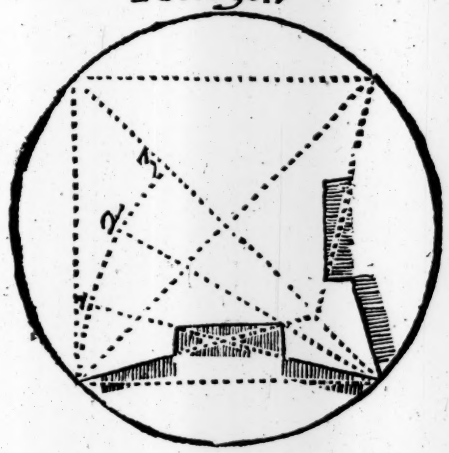


LEt the Curtain be A B. Firſt take 200 Foot from the Scale of Fortification, accounting 10 for 100; and lay the ſame from A unto C, and from C unto D: So ſhall A D be the breadth of the Neck of the Gorge: and upon the Point C erect a Perpendicular, as C F. Then take 420 Foot off your Scale, and lay the ſame from D to E, which ſhall be the length of the Curtain. Next you muſt take 720 Foot, and lay the ſame from E, to cut off the Capital Line at F; ſo ſhall E F be the longeſt Line of Defence, and C F the Capital Line; which Line C F muſt be laid down from C unto G: and draw G F for the ſhorteſt Line of Defence. Laſtly, upon D erect a Perpendicular, which will cut the ſame Line in H: ſo have you D H for the Flank, and H F the Front. Thus have you finiſhed half the Baſtion, from whence you may tranſport all the reſt of the Baſtions, were they ever ſo many.

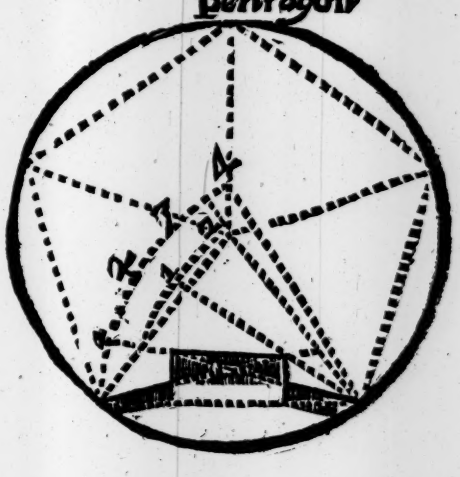
Note, That theſe Baſtions muſt not exceed 720 Foot, that ſo it may not be without Musket-ſhot. But if you will defend the Front with Cannon, you may make the Line of Defence almoſt twice ſo much. The like for the Curtain, which may be 800 Foot; and in the middle of the Curtain you may make a Spur, or Point of a Baſtion, as at K, which will be neceſſary for Musket-ſhot, beſide the Cannon; which in the Line drawn about the City of *Briſtol* I have ſeen many of them.

These five following Pieces are taken out of Malthus; *The Proportions you may find by the Scale, and the Rules before shewed.*

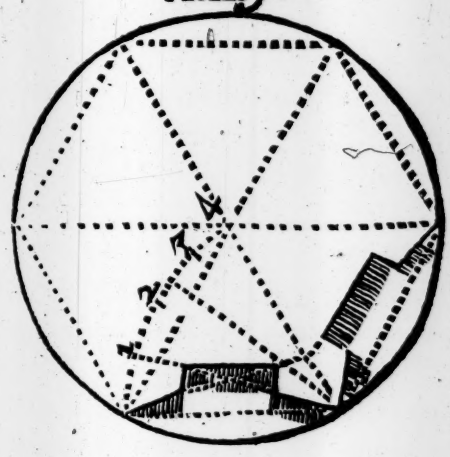
Tetragon



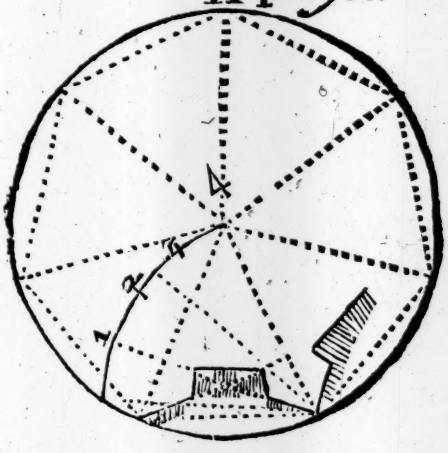
pentagon



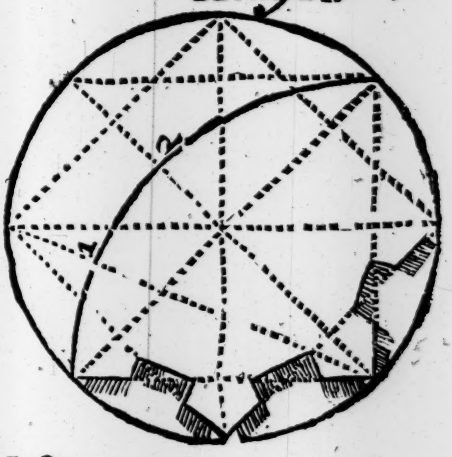
Hexagon



Heptagon



octagon



FINIS.